

Impacts of the Atlantic Multidecadal Variability on tropical climate and tropical cyclone activity

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Boulder s2d workshop, September 17th 2018



GFDL

Geophysical
Fluid
Dynamics
Laboratory

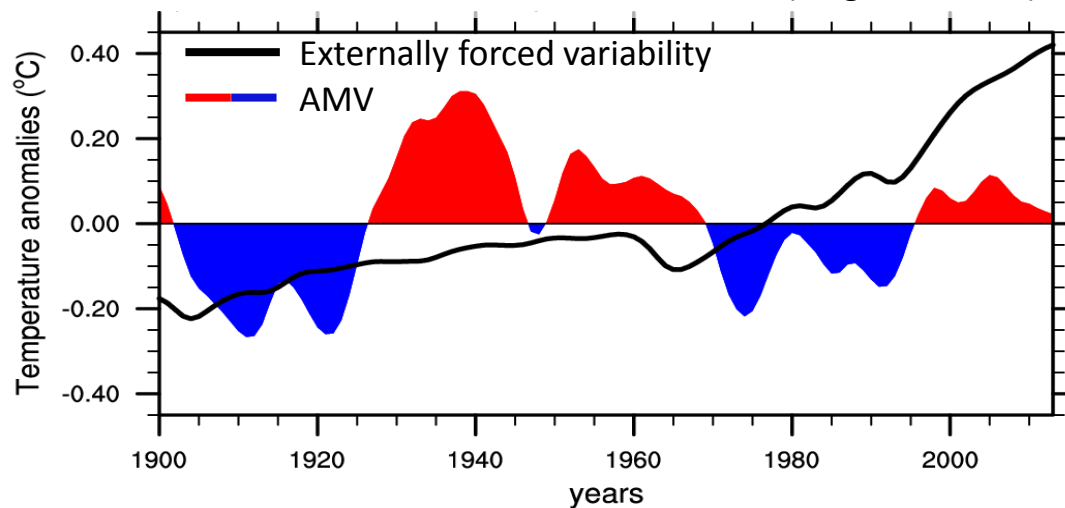


INADEC

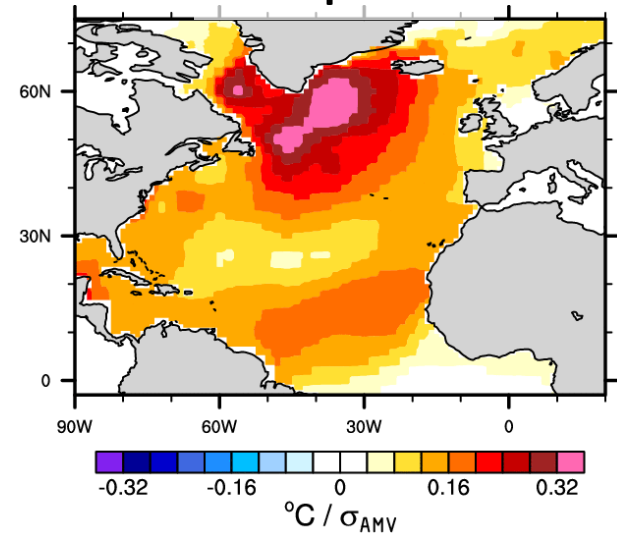
H2020-MSCA-800154

AMV impacts on climate

North Atlantic SST time series (Ting et al. 2009)



AMV pattern



Atlantic Multidecadal Variability (AMV)

- Droughts over N. and S. America
- Europ. summer temperature
- Sahel drought
- Arctic sea-ice
- Occurrence of weather extremes
- Tropical cyclone activity
- Hiatus

Motivations:

**AMV and impacts possibly predictable
multiyear ahead**

Limits:

Too short historical records

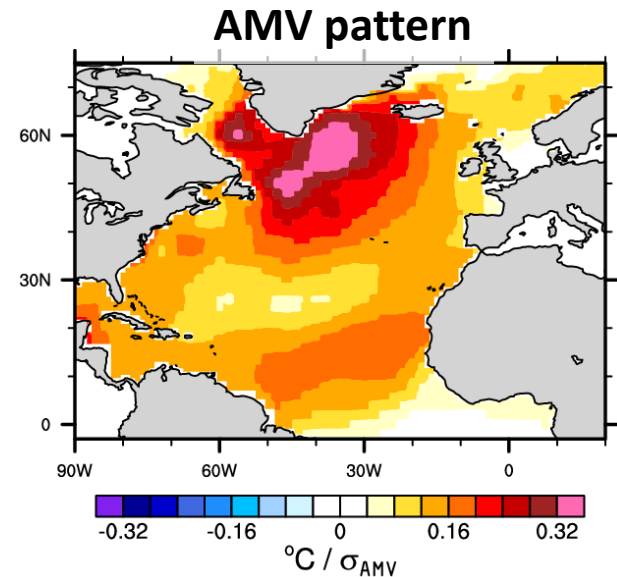
→ AMV teleconnections not fully understood

Experimental design

North Atlantic SSTs (5°N-70°N) restored to the **observed AMV pattern** with a 5/15-day restoring time scale

10yr long large ensemble experiments

Free ocean-ice-land-atmosphere interactions outside the Atlantic



AMV+ ensemble: daily North Atlantic SST \rightarrow daily Climatology + **AMV pattern**

AMV- ensemble: daily North Atlantic SST \rightarrow daily Climatology - **AMV pattern**

4 climate models

GFDL-CM2.1 = 1° ocean / **200km** atmo \rightarrow 100 members

NCAR-CESM1 = 1° ocean / **100km** atmo \rightarrow 30 members

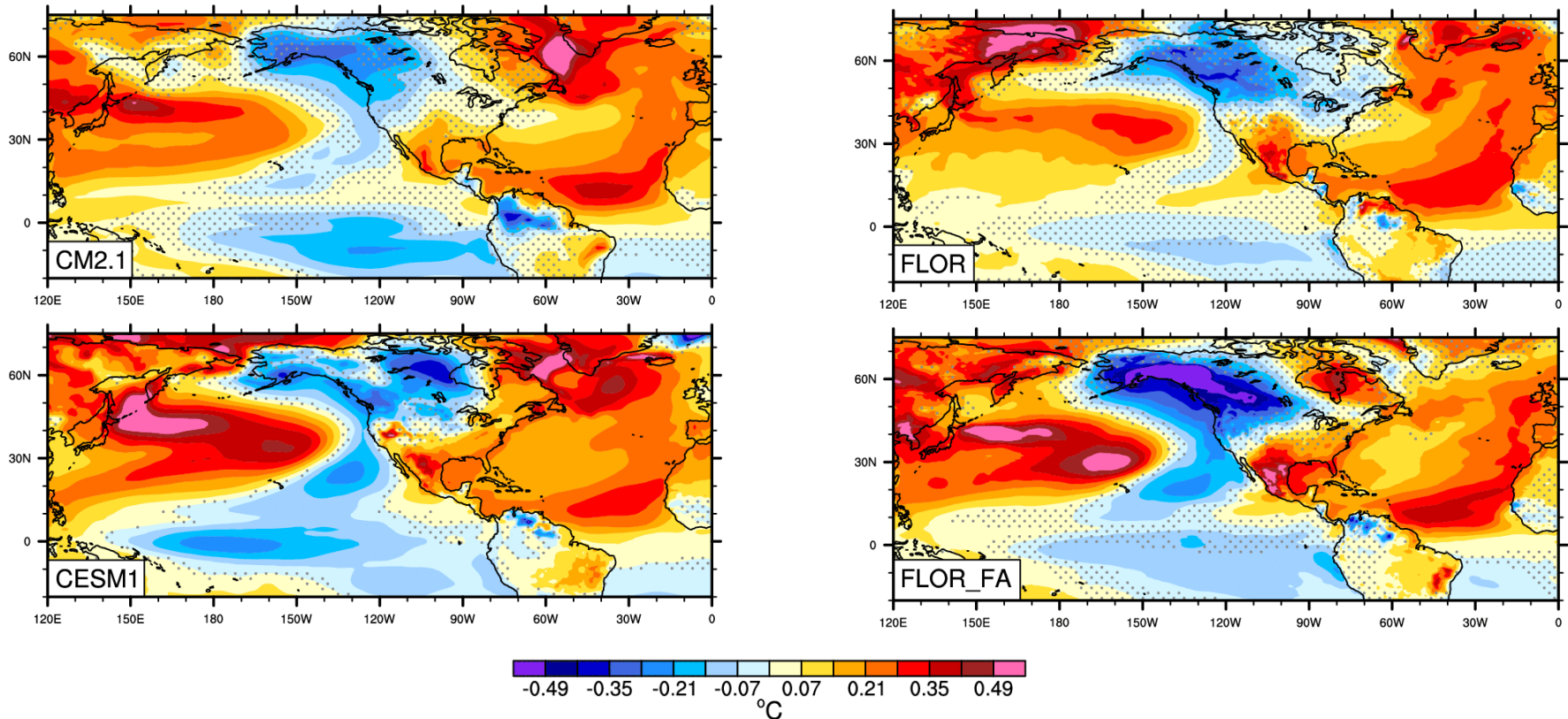
GFDL-FLOR = 1° ocean / **50km** atmo \rightarrow 50 members

GFDL-FLOR_FA = GFDL-FLOR + surface flux adjustment to reduce mean SST biases

Protocol adopted by Decadal Climate Prediction Panel of CMIP6 (Boer et al. GMD 2016)

AMV impacts on Pacific

DJFM - T2m

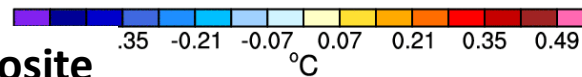
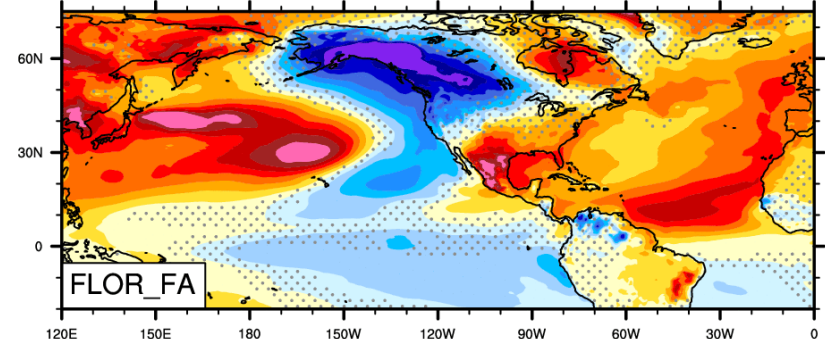
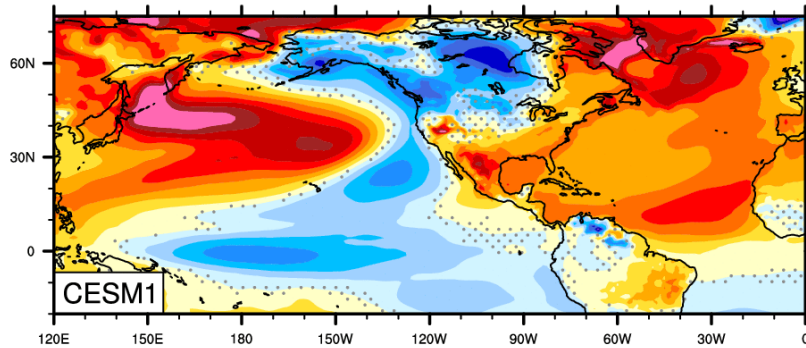
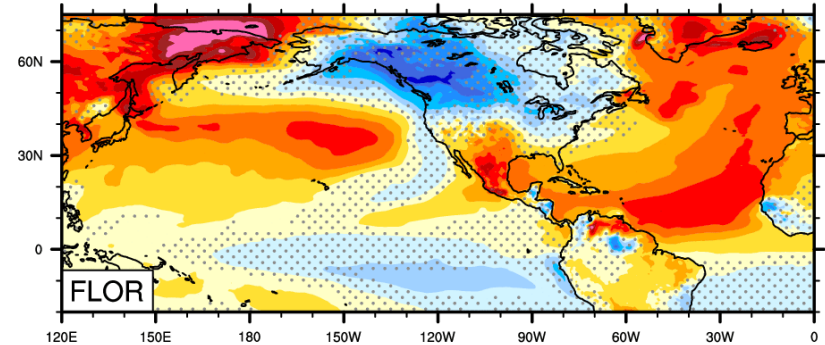
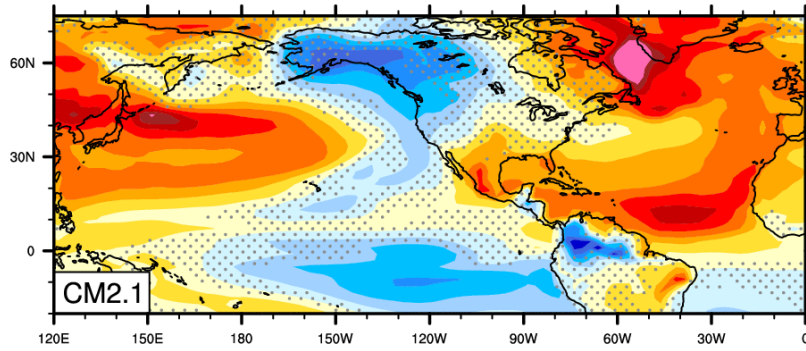


Response
AMV+ minus AMV-

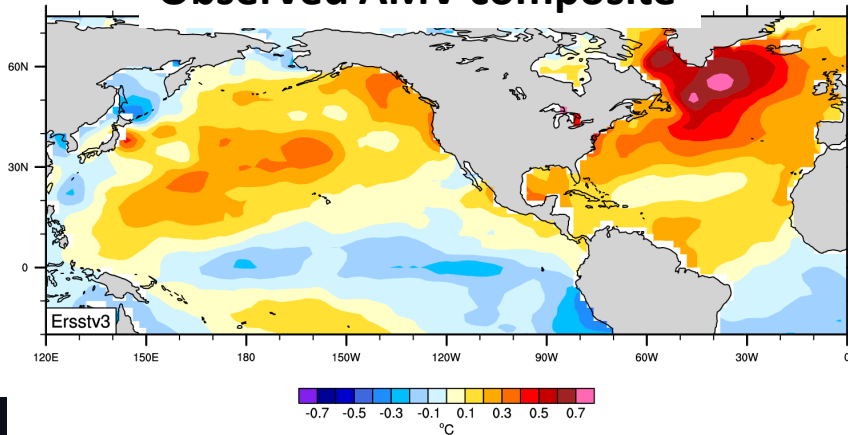
AMV+ leads negative phase of
Interdecadal Pacific Oscillation

AMV impacts on Pacific

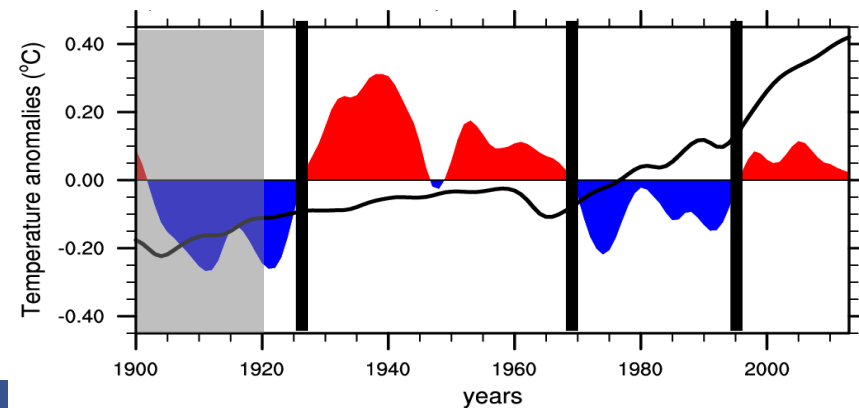
DJFM - T2m



Observed AMV composite

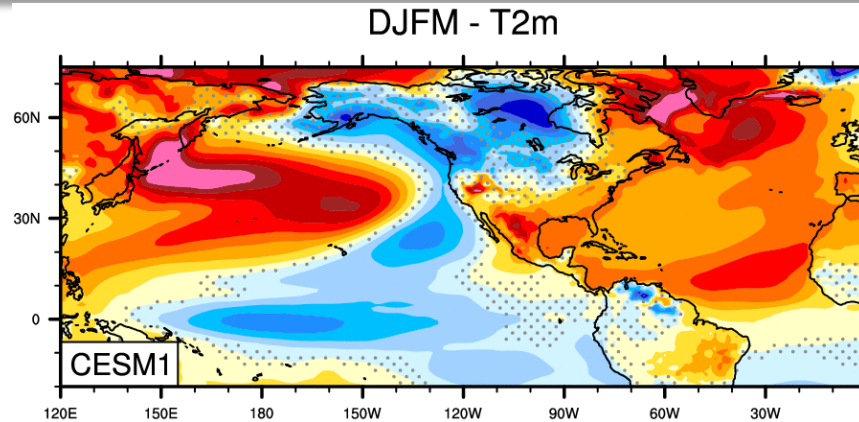


AMV time series

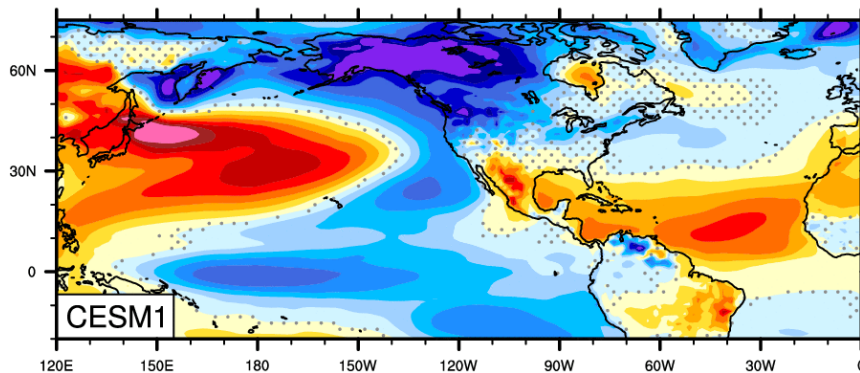


Origins of AMV impacts on Pacific

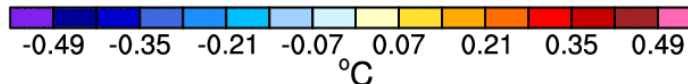
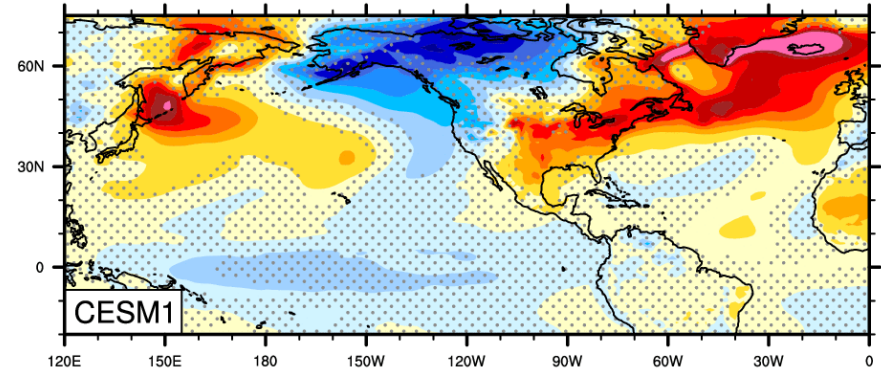
Full_AMV



Trop_AMV



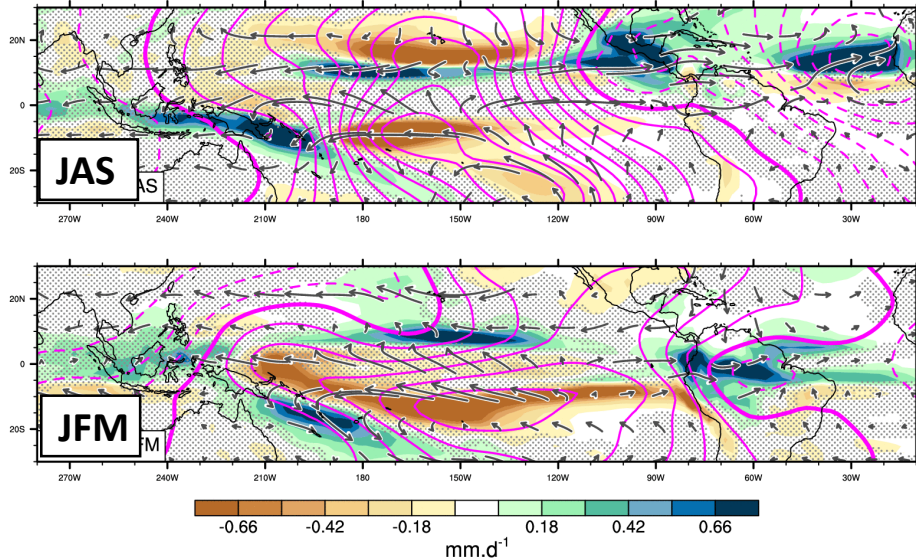
SPG_AMV



Tropical part of AMV forces Pacific response

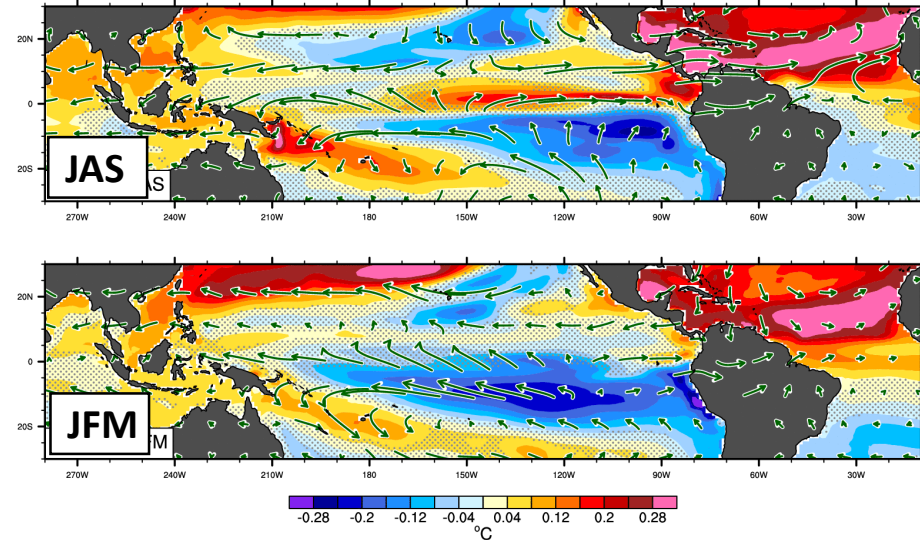
AMV impacts on Pacific: mechanism

CM2.1 – Full_AMV



Colors: precipitation
Contours: velocity potential@200hPa (wind divergence)
Arrows: wind@850hPa

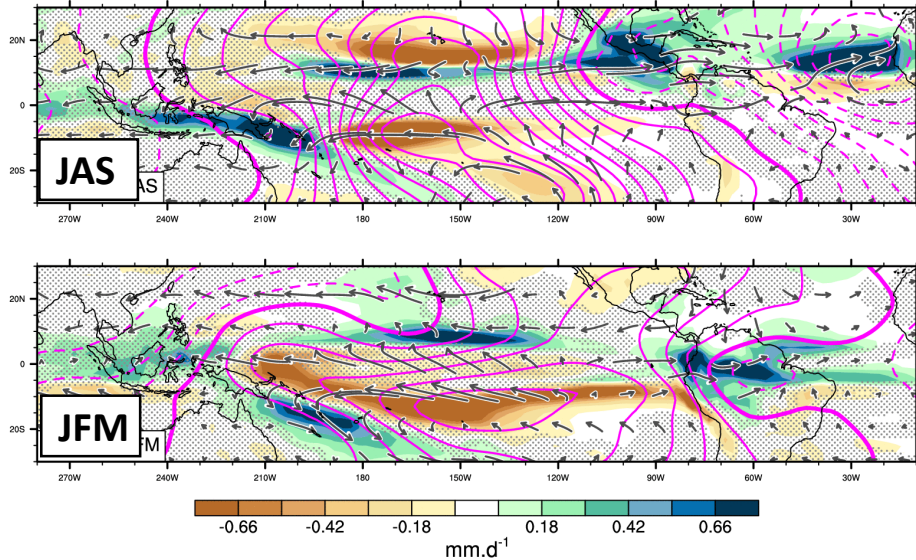
CM2.1 – Full_AMV



Colors: SST
Arrows: wind@850hPa

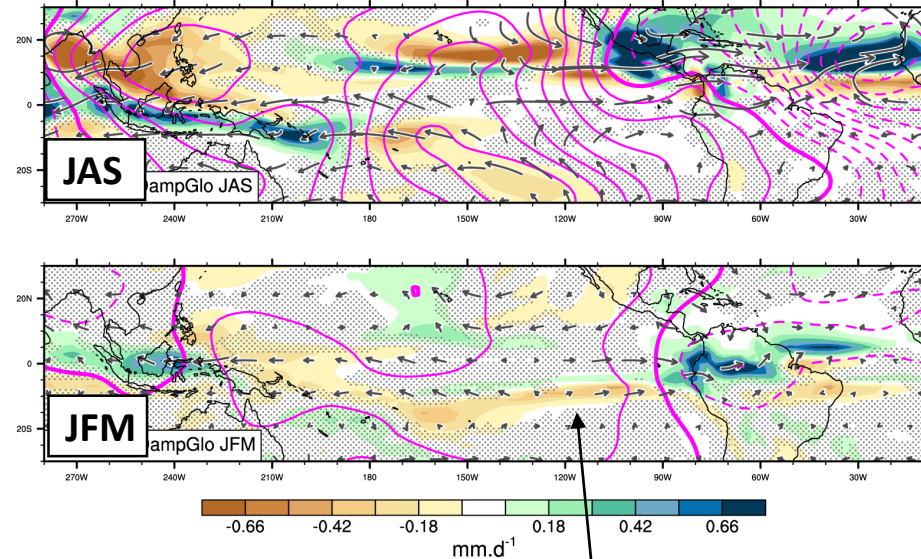
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CM2.1 – Damped_Global_AMV

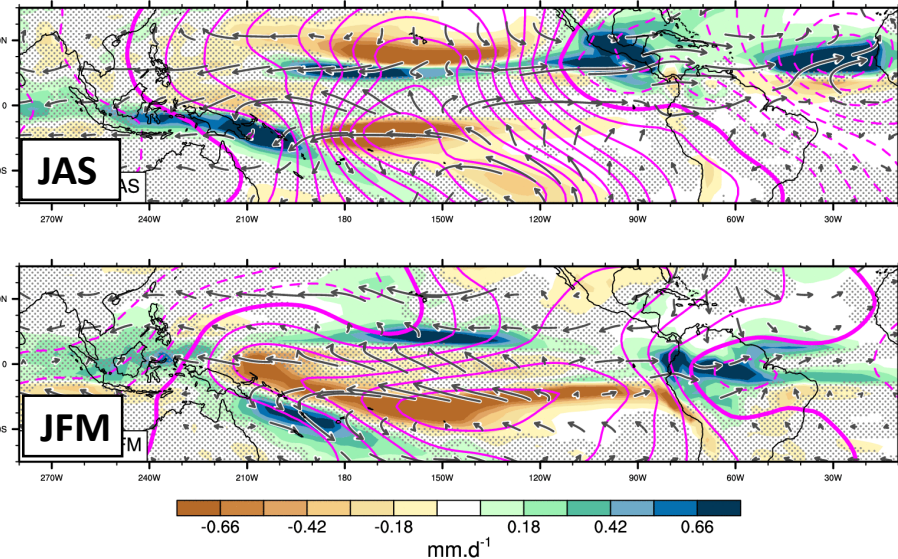


Colors: precipitation
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SST restored to its climatology

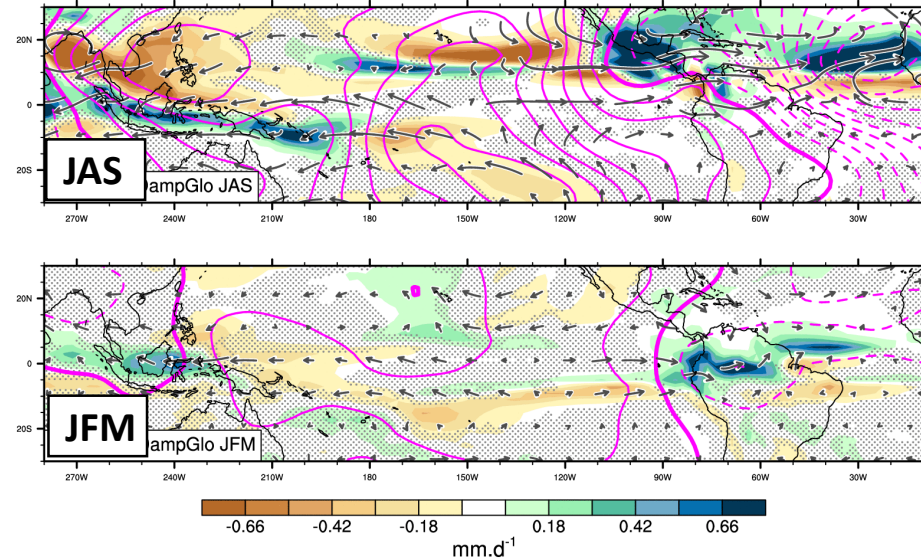
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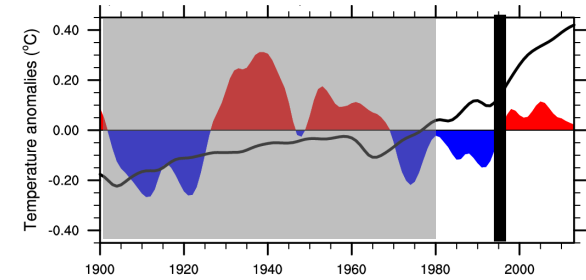
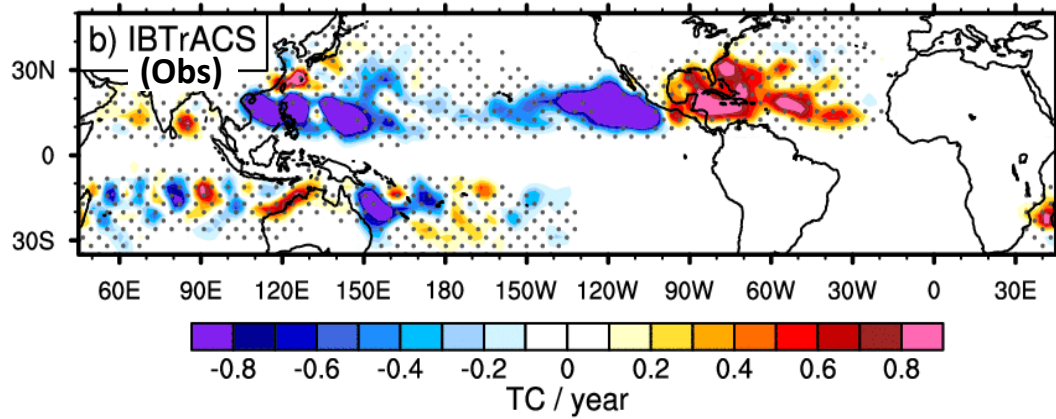
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Winter Tropical Pacific response = lagged adjustment to summer AMV forcing

Cf. Li et al. 2015: Atlantic-induced pan-tropical climate change over the past three decades
+ McGregor et al. 2014, Kucharski et al. 2012, 2015

AMV impacts on Tropical Cyclones

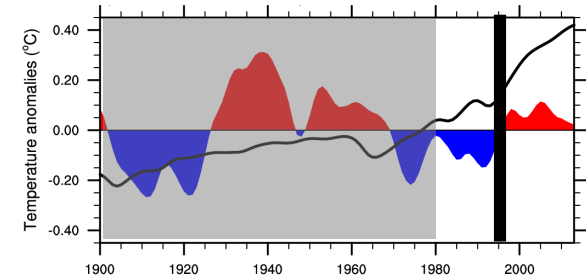
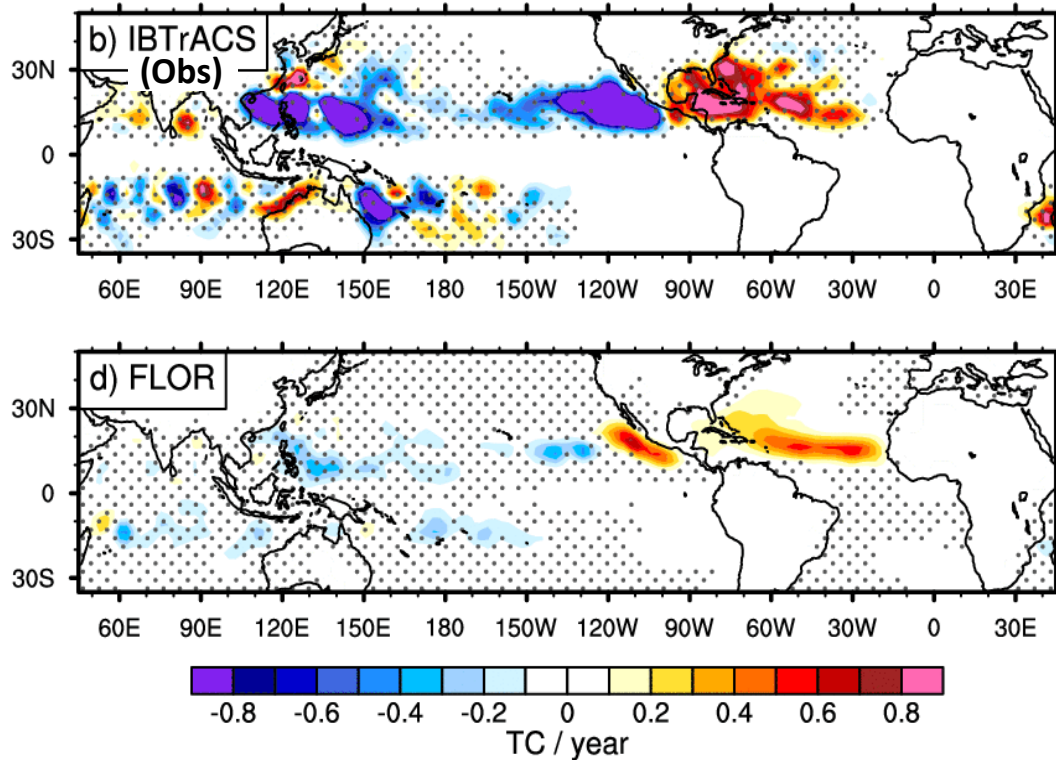
MJJASON Tropical Cyclone Density



Obs = 1996-2011 vs 1980-1995

AMV impacts on Tropical Cyclones

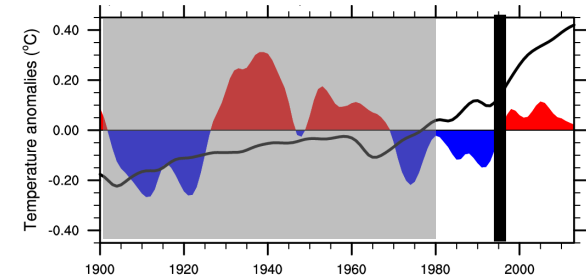
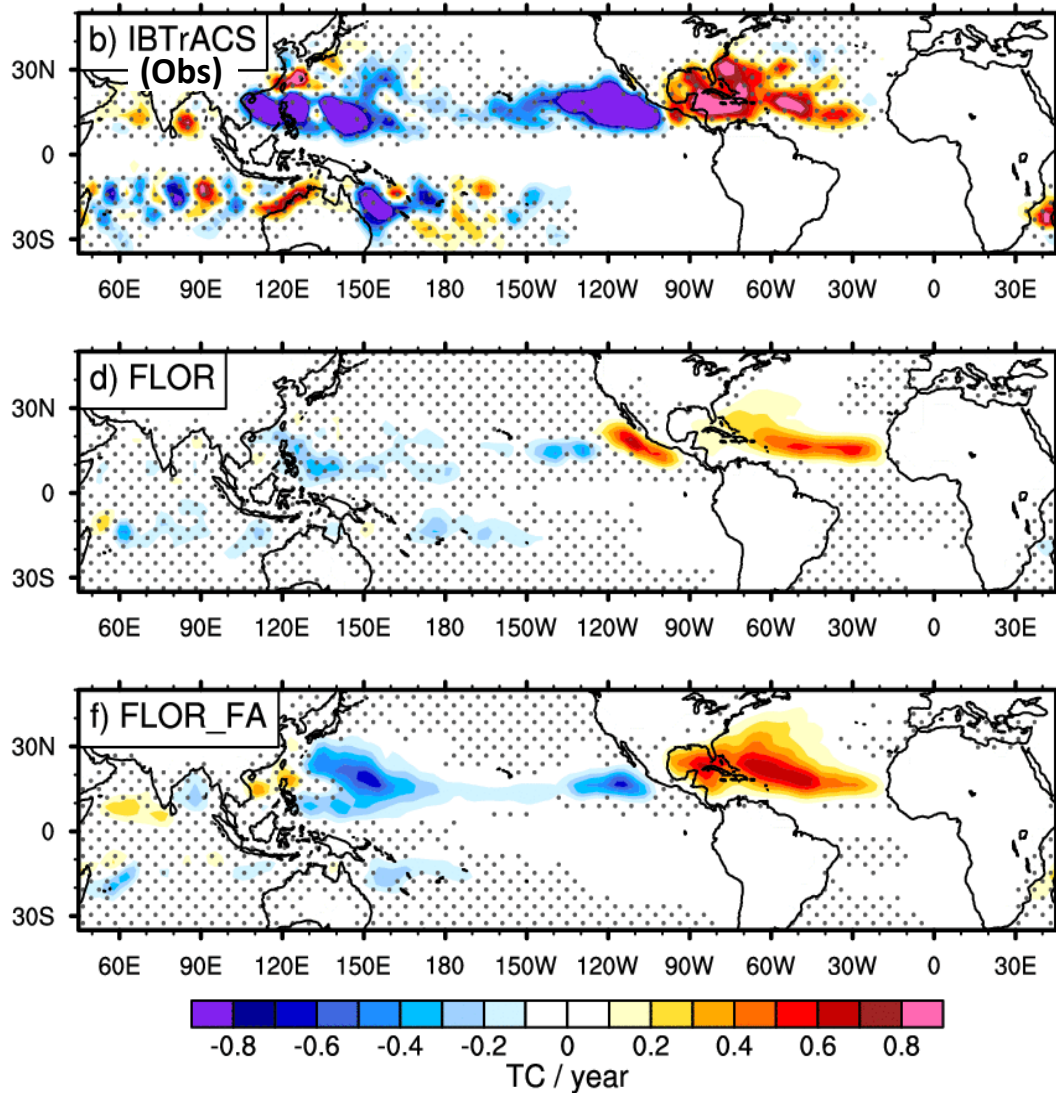
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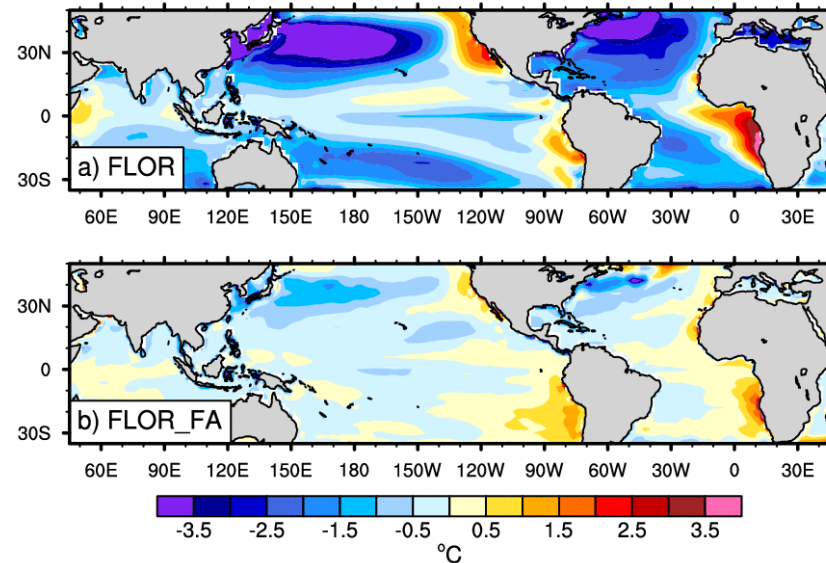
AMV impacts on Tropical Cyclones

MJJASON Tropical Cyclone Density



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MJJASON sst biases



Conclusion

- AMV+ drives IPO- response:
 - tropical Atlantic = main driver
- La-Nina like response during winter:
 - delayed adjustment to summertime Walker circulation changes
 - ➔ Need coupled model to capture such a response.

Similar impacts between CM2.1, CESM1, FLOR, FLOR_FA

- AMV impacts on TC match observed one in FLOR_FA not in FLOR

Need to correct mean SST biases to capture the observed signal

- AMV+ drives TC+ over Atlantic → SST and Wind Shear (+ humidity?)
- AMV+ drives TC- over Pacific → Wind Shear and Vorticity

Ruprich-Robert et al. (2017): *Assessing the climate impacts of the observed AMV using the GFDL-CM2.1 and NCAR CESM1 global coupled models*. **J. Clim.**

Ruprich-Robert et al.: Impacts of the AMV on tropical climate and tropical cyclone activity. In prep.

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